



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER OF PATENTS AND TRADEMARKS  
Washington, D.C. 20231  
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/506,160	02/17/2000	Bruce H.T. Chai	UCF-237	7317

7590 11/14/2002  
Brian S Steinberger  
101 Brevard Ave  
Cocoa, FL 32922

EXAMINER

HANNAHER, CONSTANTINE

ART UNIT PAPER NUMBER

2878

DATE MAILED: 11/14/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

**Notice of Allowability**

Application No.

09/506,160

Examiner

Constantine Hannaher

Applicant(s)

CHAI ET AL.

Art Unit

2878

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to submissions of 23 April 2002 and 29 April 2002.
2. ☒ The allowed claim(s) is/are 1, 4, 5 and 7-20.
3. ☐ The drawings filed on \_\_\_\_\_ are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
  - a) ☐ All    b) ☐ Some\*    c) ☐ None    of the:
    1. ☐ Certified copies of the priority documents have been received.
    2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
    3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
  - \* Certified copies not received: \_\_\_\_\_.
5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
  - (a) ☐ The translation of the foreign language provisional application has been received.
6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
8. ☐ CORRECTED DRAWINGS must be submitted.
  - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
    - 1) ☐ hereto or 2) ☐ to Paper No. \_\_\_\_\_.
  - (b) ☐ including changes required by the proposed drawing correction filed \_\_\_\_\_, which has been approved by the Examiner.
  - (c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. \_\_\_\_\_.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the top margin (not the back) of each sheet. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

- |  |  |
|--|--|
| 1 <input type="checkbox"/> Notice of References Cited (PTO-892)  | 2 <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)               |
| 3 <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                    | 4 <input checked="" type="checkbox"/> Interview Summary (PTO-413), Paper No. <u>12</u> . |
| 5 <input type="checkbox"/> Information Disclosure Statements (PTO-1449), Paper No. _____               | 6 <input checked="" type="checkbox"/> Examiner's Amendment/Comment                       |
| 7 <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit of Biological Material | 8 <input type="checkbox"/> Examiner's Statement of Reasons for Allowance                 |
|  | 9 <input type="checkbox"/> Other   |

## EXAMINER'S AMENDMENT

### Comment on Submission(s)

1. The amendment filed April 23, 2002 with the replacement for page 3 as submitted April 29, 2002 has been entered.

### Examiner's Amendment

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Brian S. Steinberger (Reg. No. 36,423) on September 27, 2002.

The application has been amended as follows:

CLEAN COPY OF ALL PARAGRAPHS CHANGED

Page 1, lines 3-7:

D<sub>1</sub>  
This application claims priority based on U.S. Provisional Application Serial No. 60/120,500 filed February 18, 1999. This invention relates to a single crystal as scintillating detector for gamma ray or similar high energy radiation which single crystal is composed of Cerium doped Lutetium Yttrium orthosilicate (LYSO) with the general composition of  $Ce_{2x}(Lu_{1-y}Y_y)_{2(1-x)}SiO_5$  where  $x=0.00001$  to  $0.05$  and  $y=0.0001$  to  $0.9999$ .

Page 2, lines 7-17:

D<sub>2</sub>  
Since the turn of this century, a large number of crystals have been proposed for potential scintillating applications. Even though they do show scintillating properties, none of them has all the right properties. The common problems are low light yield, physical weakness and difficult to

D2 produce large size high quality single crystals. Despite the problems, a number of them have found applications in physics, chemistry, geology and medicine. One common feature of all these usable crystals is that they are the only crystals which can be produced in large size and high quality by an industrial manufacturing process with reasonable cost. This common feature has proven to be the most important factor, more so than the details of scintillating properties, to be considered as a viable scintillator material. The specific examples include bismuth germanate ((BGO) which is  $\text{Bi}_4\text{Ge}_3\text{O}_{12}$ ), cerium doped gadolinium orthosilicate ((GSO) which is  $\text{Gd}_2\text{SiO}_5$ ) and cerium doped lutetium orthosilicate ((LSO) which  $\text{Lu}_2\text{SiO}_5$ ).

Page 5, lines 10-17:

D3 In the subject invention, an improved scintillation detector assembly has been realized comprising: a cerium doped lutetium yttrium orthosilicate crystal; and, a photodetector coupled to said crystal whereby an electrical signal is generated in response to a light pulse from said crystal when exposed to a high energy gamma ray. The crystal is preferably monocrystalline and of a general composition of  $\text{Ce}_{2x}(\text{Lu}_{1-y}\text{Y}_y)_{2(1-x)}\text{SiO}_5$  where  $x=0.00001$  to  $0.05$  and  $y=0.0001$  to  $0.9999$  whereby the detector utilizing said crystal as the scintillator responsive to gamma and other similar high energy radiation is particularly useful in the fields of physics, chemistry, geology and cosmology.

Page 7, line 17 to Page 8, line 3:

D4 In order to understand the melting and crystallization behavior, four intermediate LYSO charge compositions were prepared. The compositions were:  $\text{Ce}_{0.002}(\text{Lu}_{0.7}\text{Y}_{0.3})_{1.998}\text{Si}_2\text{O}_5$  designated (70% LYSO);  $\text{Ce}_{0.002}(\text{Lu}_{0.5}\text{Y}_{0.5})_{1.998}\text{Si}_2\text{O}_5$  designated (50% LYSO);  $\text{Ce}_{0.002}(\text{Lu}_{0.3}\text{Y}_{0.7})_{1.998}\text{Si}_2\text{O}_5$  designated (30% LYSO); and,  $\text{Ce}_{0.002}(\text{Lu}_{0.15}\text{Y}_{0.85})_{1.998}\text{Si}_2\text{O}_5$  designated as (15% LYSO). The percentage refers to the fraction of the lutetium in the crystal. A pure LSO charge was also prepared to be processed in a similar way as a reference for direct comparison. To make sure that the property comparison is

26

D4  
meaningful, all the LYSO crystal preparation procedures are identical. The same total number of moles of chemicals in each case were used so that the finished crystals are near identical in size. To minimize the repetition, the 70% LYSO composition is hereafter set forth as the example to illustrate the preparation for all examples:

Page 11, line 14 to Page 12, line 2:

D5  
In addition to the advantage directly observed from the light yield measurements, LYSO also resolves other problems associated with pure LSO. First the growth temperature of LYSO is lower than that of pure LSO be approximately 100 °C which is very significant in high temperature processes. Since the radiation heat loss is proportional to the 4<sup>th</sup> power of temperature (or  $T^n$ ) the high temperature insulation and iridium crucible will last longer. Second, substituting yttrium will reduce proportionally the trace concentration of the naturally radioactive  $\text{Lu}^{176}$  isotope without sacrificing the net light yield. This will, in effect, reduce the background noise of the detector. Third, both the cost and purity of the  $\text{Lu}_2\text{O}_3$  starting material is a serious issue. Thus, yttrium substitution will reduce the cost and improve the uniformity of scintillating efficiency for large single crystal plates. Further, since a low index of refraction is preferred for scintillating crystals to reduce the effect of total internal reflection, the substitution of yttrium reduces the already low value of the index of refraction of LSO.

This amendment is necessary to permit the specification to offer antecedent basis for the terms of the claims as needed by 37 CFR 1.78(d)(1), and to correct informalities in the specification as previously objected to in paragraph 3 of the Office action mailed October 19, 2001 at: page 2, line 16; page 7, lines 18, 19, and 20; page 11, lines 16 and 21.

### Conclusion

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Constantine Hannaher whose telephone number is (703) 308-4850. The examiner can normally be reached on Monday-Friday with flexible hours.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David P. Porta can be reached on (703) 308-4852. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

ch  
September 27, 2002

  
Constantine Hannaher  
Primary Examiner

2

## VERSION OF AMENDMENT MARKED UP TO SHOW CHANGES

Page 1, lines 3-7:

This application claims priority based on U.S. Provisional Application Serial No. 60/120,500 filed February 18, 1999. This invention relates to a single crystal as scintillating detector for gamma ray or similar high energy radiation which single crystal is composed of Cerium doped Lutetium Yttrium orthosilicate (LYSO) with the general composition of  $Ce_{2x}(Lu_{1-y}Y_y)_{2(1-x)}SiO_5$  where  $x=0.00001$  to  $0.05$  and  $y=0.0001$  to  $0.9999$  [ $x=0.0001$  to  $0.02$  and  $y=0.0001$  to  $1.9999$  and claims priority based on U.S. Provisional Application Serial No. 60/120,500 filed Feb. 18, 1999].

Page 2, lines 7-17:

Since the turn of this century, [; there are] a large number of crystals have been proposed for potential scintillating applications. Even though they do show scintillating properties, none of them has all the right properties. The common problems are low light yield, physical weakness and difficult to produce large size high quality single crystals. Despite the problems, a number of them have found applications in physics, chemistry, geology and medicine. One common feature of all these usable crystals is that they are the only crystals which can be produced in large size and high quality by an industrial manufacturing process with reasonable cost. This common feature has proven to be the most important factor, more so than the details of scintillating properties, to be considered as a viable scintillator material. The specific examples include bismuth germanate ((BGO) which is  $Bi_4Ge_3O_{12}$  [ $Bi_4Ge_3O_{12}$ ]), cerium doped gadolinium orthosilicate ((GSO) which is  $Gd_2SiO_5$ ) and cerium doped lutetium orthosilicate ((LSO) which  $Lu_2SiO_5$ ).

Page 5, lines 10-17:

In the subject invention, an improved scintillation detector assembly has been realized comprising: a cerium doped lutetium yttrium orthosilicate crystal; and, a photodetector coupled to

said crystal whereby an electrical signal is generated in response to a light pulse from said crystal when exposed to a high energy gamma ray. The crystal is preferably monocrystalline and of a general composition of  $Ce_{2x}(Lu_{1-y}Y_y)_{2(1-x)}SiO_5$  where  $x=0.00001$  to  $0.05$  and  $y=0.0001$  to  $0.9999$  [ $x=0.0001$  to  $0.02$  and  $y=0.0001$  to  $1.9999$ ] whereby the detector utilizing said crystal as the scintillator responsive to gamma and other similar high energy radiation is particularly useful in the fields of physics, chemistry, geology and cosmology.

Page 7, line 17 to Page 8, line 3:

In order to understand the melting and crystallization behavior, four intermediate LYSO charge compositions were prepared. The compositions were:  $Ce_{0.002}(Lu_{0.7}Y_{0.3})_{1.998}Si_2O_5$  [ $Ce_{0.002}(Lu_{0.7}Y_{0.3})_{1.998}Si_2O_5$ ] designated (70% LYSO);  $Ce_{0.002}(Lu_{0.5}Y_{0.5})_{1.998}Si_2O_5$  [ $Ce_{0.002}(Lu_{0.5}Y_{0.5})_{1.998}Si_2O_5$ ] designated (50% LYSO);  $Ce_{0.002}(Lu_{0.3}Y_{0.7})_{1.998}Si_2O_5$  designated (30% LYSO); and,  $Ce_{0.002}(Lu_{0.15}Y_{0.85})_{1.998}Si_2O_5$  [ $Ce_{0.002}(Lu_{0.15}Y_{0.85})_{1.998}Si_2O_5$ ] designated as (15% LYSO). The percentage refers to the fraction of the lutetium in the crystal. A pure LSO charge was also prepared to be processed [processes] in a similar way as a reference for direct comparison. To make sure that the property comparison is meaningful, all the LYSO crystal preparation procedures are identical. The same total number of moles of chemicals in each case were used so that the finished crystals are near identical in size. To minimize the repetition, the 70% LYSO composition is hereafter set forth as the example to illustrate the preparation for all examples:

Page 11, line 14 to Page 12, line 2:

In addition to the advantage directly observed from the light yield measurements, LYSO also resolves other problems associated with pure LSO. First the growth temperature of LYSO is lower than that of pure LSO be approximately  $100^{\circ}C$  [C] which is very significant in high temperature processes. Since the radiation heat loss is proportional to the  $4^{th}$  power of temperature (or  $T^n$ ) the



high temperature insulation and iridium crucible will last longer. Second, substituting yttrium will reduce proportionally the trace concentration of the naturally radioactive  $\text{Lu}^{176}$  isotope without sacrificing the net light yield. This will, in effect, reduce the background noise of the detector. Third, both the cost and purity of the  $\text{Lu}_2\text{O}_3$  [ $\text{Lu}_2\text{O}_3$ ] starting material is a serious issue. Thus, yttrium [Yttrium] substitution will reduce the cost and improve the uniformity of scintillating efficiency for large single crystal plates. Further, since a low index of refraction is preferred for scintillating crystals to reduce the effect of total internal reflection, the substitution of yttrium reduces the already low value of the index of refraction of LSO.